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(71) Applicant: **SEIKO ELECTRONIC COMPONENTS LTD.**
30-1, Nishitaga 5-chome
Sendai-shi Miyagi (JP)

(72) Inventor: **Hirama, Hideo**
Seiko Electronic Com. Ltd. 30-1 Nishitaga 5-chome
Sendai-shi Miyagi-ken (JP)

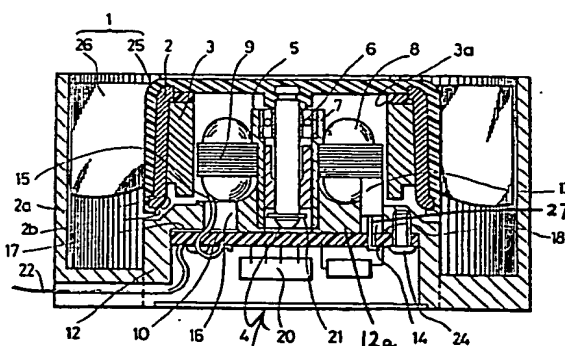
Hayashizaki, Shinichi
Seiko Electronic Comp. Ltd. 30-1 Nishitaga 5-chome
Sendai-shi Miyagi-ken (JP)

(74) Representative: **Miller, Joseph et al**
J. MILLER & CO. Lincoln House 296-302 High Holborn
London WC1V 7JH (GB)

(54) Axial flow fan.

(57) An axial flow fan comprising a rotary member (1-4, 25) provided with a fan member (1); a motor portion (8,9) of an electric motor for rotating the rotary member (1-4, 25); a circuit board (10) carrying an electrical component or components (20) for controlling the operation of the motor portion (8,9); and a housing (12) having a housing portion (12a) to one side of which the rotary member (1-4, 25) and the motor portion (8,9) are mounted characterised in that the circuit board (10) is mounted on the opposite side of the housing portion (12a), the axial flow fan having been assembled by introducing the rotary member (1-4, 25) and the motor portion (8,9) into the housing (12) from the said one side, and introducing the circuit board (10) into the housing (12) from the said opposite side.

FIG. 2



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Description

AXIAL FLOW FAN

The present invention relates to an axial flow fan and, although it is not so restricted, it relates more particularly to an axial flow fan disposed in a casing of an office-automation instrument to circulate air therethrough so as to cool heated parts thereof.

An axial flow fan is known comprising a rotary member provided with a fan member; a motor portion of an electric motor for rotating the rotary member; a circuit board carrying an electrical component or components for controlling the operation of the motor portion; and a housing having a housing portion to one side of which the rotary member and the motor portion are mounted. In the known axial flow fan, the motor portion and the circuit board are inserted into the housing from the same direction when they are assembled into a superposed structure.

In such a structure, however, the central portion of the circuit board has a relatively large opening for the passage therethrough of a shaft support sleeve. For this reason, the circuit board has a limited amount of space available for electrical components and there is limited flexibility for the arrangement of these components. Further, the circuit board is disposed under and is covered by the motor portion so that it cannot be removed separately once it is assembled into the housing. Replacement, repair and adjustment of the circuit board are therefore difficult.

It is also known to insert the yoke of the motor portion of a fan into the latter during moulding of an integrated rotor. In such insert-moulding, a cylindrical yoke is utilized having a linear wall. In order to form such a yoke, a metal plate is embossed by a press in the axial direction of the cylindrical yoke and thereafter the top end portion is cut by the press in a direction perpendicular to the axial direction. However, such cutting is difficult to perform and re-shaping may be needed subsequently so that the cost of production may be high. In addition, the end portion of the yoke has a sheared edge which makes the insertion of a magnet into the yoke difficult.

According, therefore, to one aspect of the present invention, there is provided an axial flow fan comprising a rotary member provided with a fan member; a motor portion of an electric motor for rotating the rotary member; a circuit board carrying an electrical component or components for controlling the operation of the motor portion; and a housing having a housing portion to one side of which the rotary member and the motor portion are mounted characterised in that the circuit board is mounted on the opposite side of the housing portion, the axial flow fan having been assembled by introducing the rotary member and the motor portion into the housing from the said one side, and introducing the circuit board into the housing from the said opposite side.

Preferably the rotary member comprises a hollow fan hub having an opening at one end thereof, and a hollow yoke disposed inside the hub, the hollow

yoke having a tapered shape such that its internal diameter increases towards the said hub opening.

The yoke may be insert-moulded into the fan hub.

Preferably the inner diameter of the said opening of the fan hub is greater than that of the end of the yoke remote from said opening.

According to another aspect of the present invention, there is provided an axial flow fan comprising a rotary member provided with a fan member, a hollow fan hub having an opening at one end thereof, and a hollow yoke disposed within the hub; and a motor portion for rotating the rotary member characterised in that the hollow yoke has a tapered shape such that its internal diameter increases towards the hub opening.

The yoke may be cup-shaped having an end portion with an opening therein in which a portion of the hub is mounted.

The yoke and hub may be moulded together to form an integral structure.

The yoke is preferably provided at its larger end portion with a radiused surface to facilitate the introduction into the yoke of a magnet which forms part of the rotary member.

The invention is illustrated, merely by way of example, in the accompanying drawings, in which:-

Figure 1 is a sectional view of a known axial flow fan;

Figure 2 is a sectional view of an axial flow fan according to the present invention,

Figure 3 is a plan view of part of the structure shown in Figure 2 and showing a support face of a housing thereof for a circuit board;

Figure 4 is a plan view of the said circuit board; and

Figure 5 is a sectional view of a yoke forming part of the structure shown in Figure 2.

As shown in Figure 1, a known axial flow fan has a fan member 1, a fan shaft 4, a coil 8, a core 9, a Hall device 13, and a circuit board 10 to which the coil 8 is connected by a lead wire 15 and which is connected to a power source (not shown) by a power line 22. The circuit board 10 is secured to a housing 12 by a screw 24. The parts 8, 9 which form a motor portion and the circuit board 10 are inserted into the housing 12 from the same direction when they are assembled into a superposed structure.

The fan shown in Figure 1, moreover, has a rotary member which, in addition to comprising the fan member 1 and shaft 4, also comprises a hollow fan hub 25 having an opening at its bottom end and a hollow yoke 2 disposed inside the hub 25, a magnet 3 being mounted in and carried by the yoke 2. The yoke 2 and the hub 25 can be attached to each other by adhesive or by welding.

In such a structure, however, the central portion of the circuit board 10 has a relatively large opening for the passage therethrough of a sleeve 5 which is used to support the shaft 4 by way of a ball bearing 6. Because of this, the circuit board 10 has a limited amount of effective space for electrical components

and there is limited flexibility for the arrangement of these components. Further, the circuit board 10 is disposed under and is covered by the motor portion 8, 9 so that the circuit board 10 cannot be removed separately once it is assembled into the housing 12. Replacement, repair and adjustment of the circuit board 10 are therefore difficult.

In Figure 2 there is therefore shown an axial flow fan according to the present invention in which a fan member 1 is insert-moulded together with a yoke 2, a magnet 3 and a shaft 4 to form an integrated rotary member. A sleeve 5 forms a shaft support portion of a housing 12 having a substantially U-shaped base portion 12a. Inside the sleeve 5 there is mounted a ball bearing 6 and a ring 7 composed of oil-less metal. The sleeve 5 supports about it a motor or drive portion of an electric motor for rotating the said rotary member, the motor portion comprising a coil 8 and a core 9 which holds the coil 8. The fan member 1 is mounted on the shaft 4 which is itself rotatably mounted in the sleeve or shaft support portion 5. The shaft 4 is positioned in the thrust direction by means of a stopper washer 21 which is engaged in a slit recess formed in the end of the shaft 4.

The above-mentioned members are assembled into the housing 12 from the same direction (from the top side in Figure 2). Next, reference will be made to other members which are assembled from the bottom side in Figure 2. A circuit board 10 is attached to and disposed below the base portion 12a of the housing 12 by means of a sole screw 24. The circuit board 10 has mounted thereon an electronic component 20 for controlling the operation of the motor portion 8, 9. A Hall device 13 is supported by and above the circuit board 10 by way of a support member 27 which is secured to the bottom of the circuit board 10. The Hall device 13 is mounted in position by passing it through a rectangular hole 14 in the base portion 12a of the housing 12 so as to extend adjacent to a bottom face of the core 9 which will thus be adjacent the top of the Hall device 13. A lead wire 15 of the coil 8 passes downwardly through a round hole 16 in the base portion 12a of the housing 12 and is attached to the circuit board 10. A cavity 17 in the bottom surface of the base portion 12a of the housing 12 is provided to receive therein a curved intermediate portion of the lead wire 15 so as to avoid the application of excessive stress to the circuit board 10. A portion 18 of the base portion 12a of the housing 12 is tapered to avoid vertical displacement of the circuit board 10 at the radially opposite side thereof from the housing 12 when the circuit board 10 is fixed to the housing 12 by means of the sole screw 24. Consequently, the motor portion 8, 9 and the rotary member 1-4, on the one hand, and the circuit board 10, on the other hand, are separately assembled into the housing 12 from opposite directions. The lead wire 15 from the assembled motor portion 8, 9 passes through the round hole 16 and is fitted into a peripheral recess 19 (Figure 4) of the circuit board 10, being guided to the face of circuit board 10 and being connected thereat by welding. In a similar manner, a power line 22, which supplies electric power from the outside, is

connected to the circuit board 10. Thus the circuit board 10 functions at least to interconnect the lead wire 15 and the power line 22 to each other.

As shown in Figure 5, the yoke 2 is a hollow cup-shaped member formed by emboss-pressing and thereafter punch-pressing in the same direction while leaving top and bottom edge portions. The thus formed yoke 2 is insert-moulded to form an integrated hollow hub 25 in which the bottom edge portion 2a of the yoke 2 surrounds the opening of the hollow hub 25. The opening edge 2b of the hub 25 is made of moulded plastics and is disposed radially outside the bottom edge portion 2a of the yoke 2. Moreover, the inner diameter of the hub 25 at the opening edge 2b is greater than that of the end of the yoke 2 remote from the opening edge 2b. The shaft 4 is also insert-moulded as a part of the integrated fan member 1. The magnet 3 is formed with a step portion 3a for positioning it. The magnet 3 is inserted through the bottom opening defined by the bottom edge portion 2a of the yoke 2 and is fixed to the yoke 2 by adhesive. In another embodiment, the thus formed yoke 2, magnet 3 and fan member 1 may be integrally moulded to form the rotary member.

As shown in Figure 5, the top end portion of an embossed or press-drawn cup-shaped metal member is punch-pressed in the direction of an arrow B parallel to that of the emboss-pressing while leaving a peripheral portion of the top end portion to form the yoke 2. The thus formed yoke is insert-moulded with the hollow hub 25 so that the bottom end portion 2a of the yoke 2 has an opening diameter which is greater than that of the top end portion of the yoke 2 and which surrounds the opening of the hollow hub 25, as shown in Figure 2. Stated otherwise, plastics material is removed from the opening of the bottom end portion 2a of the yoke 2.

The hollow yoke 2 has a tapered shape such that its internal diameter increases towards the hub opening. The yoke 2 has an end portion 2c with an opening 2d therein in which a portion of the hub 25 is mounted. The yoke 2 is provided at its larger end portion with the bottom edge portion 2a which is radiused to facilitate the introduction into the yoke 2 of the magnet 3.

The motor portion 8, 9 and the rotary portion of the fan including the shaft 4 are successively introduced into the housing 12 from the same direction. Next, the circuit board 10 is assembled into the housing 12 from the opposite direction (i.e. from the bottom side as shown in Figure 2).

As indicated above, the yoke 2 may be formed by embossing or by drawing and punching in the same press direction. The opening edge portion of the fan hub is curved outwardly so as to easily enable the insertion of the magnet 3 into the yoke 2. Namely, the yoke 2 has a top end portion having a sheared edge arranged inside the inner diameter of the yoke, and a bottom end portion having a sheared edge arranged outside the outer diameter of the yoke.

As described above, the motor or drive portion 8, 9 and the rotary member 1-4, on the one hand, and the circuit board 10, on the other hand, are separately sub-assembled, and are inserted into the upper and

lower sections, respectively, of the housing 12 from opposite directions so as to achieve the following advantages.

The respective components are efficiently assembled together to simplify production control. Specifically, sub-assembling of the motor portion 8, 9 and the rotary member 1-4 can be carried out without disturbing production on the circuit board assembly line.

The effective space provided on the circuit board 10 is increased and cheap electronic components of large size having general utility can be utilized. The flexibility of circuit and pattern design is thus increased. In addition to advantages such as the increased ease of assembly of the circuit, the circuit board 10 has sufficient space for the mounting of components such that the circuit board 10 can be provided at its central portion with a small hole 23 (Figure 4) through which the stopper washer 21 can be removed so as to detach the rotational member 1-4 while leaving the circuit board 10 as it is.

The Hall device 13 is accurately positioned by means of the guiding effected through the rectangular hole 14 to ensure magnetic coupling between the Hall device 13 and the core 9 of the motor portion 8, 9.

During the step of connecting the lead wire 15 to the circuit board 10, the lead wire 15 is temporarily fitted into the peripheral recess 19 and the end portion of the lead wire 15 is connected to the circuit board 10 so as to simplify the connecting process.

Replacement, repair and adjustment of the circuit board 10 due to defects in the electronic circuit or to a mis-match between the circuit board and the motor portion 8, 9 can be carried out by simply releasing the single screw 24.

Since the yoke 2 is formed by embossing or drawing press work and punching press work in the same direction and the edge portion 2a surrounding the fan hub opening is curved radially outwardly, the number of working steps is reduced so as to reduce the production costs of the yoke 2 and so that the insertion of the magnet 3 into the yoke 2 can be simplified.

Claims

1. An axial flow fan comprising a rotary member (1-4, 25) provided with a fan member (1); a motor portion (8,9) of an electric motor for rotating the rotary member (1-4, 25); a circuit board (10) carrying an electrical component or components (20) for controlling the operation of the motor portion (8,9); and a housing (12) having a housing portion (12a) to one side of which the rotary member (1-4, 25) and the motor portion (8,9) are mounted characterised in that the circuit board (10) is mounted on the opposite side of the housing portion (12a), the axial flow fan having been assembled by introducing the rotary member (1-4,25) and the motor portion (8,9) into the housing (12) from

the said one side, and introducing the circuit board (10) into the housing (12) from the said opposite side.

2. An axial flow fan as claimed in claim 1 characterised in that the rotary member (1-4, 25) comprises a hollow fan hub (25) having an opening at one end thereof, and a hollow yoke (2) disposed inside the hub (25), the hollow yoke (2) having a tapered shape such that its internal diameter increases towards the said hub opening.

3. An axial flow fan as claimed in claim 2 characterised in that the yoke (2) is insert-moulded into the fan hub (25).

4. An axial flow fan as claimed in claim 2 or 3 characterised in that the inner diameter (2b) of the said opening of the fan hub (25) is greater than that of the end of the yoke (2) remote from said opening.

5. An axial flow fan comprising a rotary member (1-4,25) provided with a fan member (1), a hollow fan hub (25) having an opening at one end thereof, and a hollow yoke (2) disposed within the hub (25); and a motor portion (8,9) for rotating the rotary member (1-4, 25) characterised in that the hollow yoke (2) has a tapered shape such that its internal diameter increases towards the hub opening.

6. An axial flow fan as claimed in claim 5 characterised in that the yoke (2) is cup-shaped having an end portion (2c) with an opening (2d) therein in which a portion of the hub (25) is mounted.

7. An axial flow fan as claimed in claim 5 or 6 characterised in that the yoke (2) and hub (25) are moulded together to form an integral structure.

8. An axial flow fan as claimed in any of claims 5-7 characterised in that the yoke (2) is provided at its larger end portion with a radiused surface (2a) to facilitate the introduction into the yoke (2) of a magnet (3) which forms part of the rotary member (1-4,25).

9. In an axial flow fan including a rotational member (1-4,25) having a fan (1) for producing air flow, a motor portion (8,9) for rotating the fan (1), a circuit board (10) for driving the motor portion (8,9) and a housing (12) for mounting therein the rotational member (8,9), motor portion (1-4) and the circuit board (10), the improvement wherein the housing (12) has an upper section for accommodating therein the rotational member (1-4,25) and motor portion (8,9) attachable to the housing from the top portion of housing, and a lower section for accommodating therein the circuit board (10) attachable to the housing (12) from the bottom portion of housing (12).

10. In an axial flow fan including a rotational member (1-4,25) having a fan (1) for producing air flow, a motor portion (8,9) for rotating the fan (1), and a housing (12) for mounting therein the rotational member (1-4,25) and motor portion (8,9), the improvement wherein the rotational member (1-4,25) has a hollow fan hub (25)

formed with an opening, and a yoke (2) disposed within the hub (25), the yoke (2) being formed in an axially tapered shape having one end portion of smaller diameter and the other end portion of greater diameter which borders the hub opening.

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FIG. 1
PRIOR ART

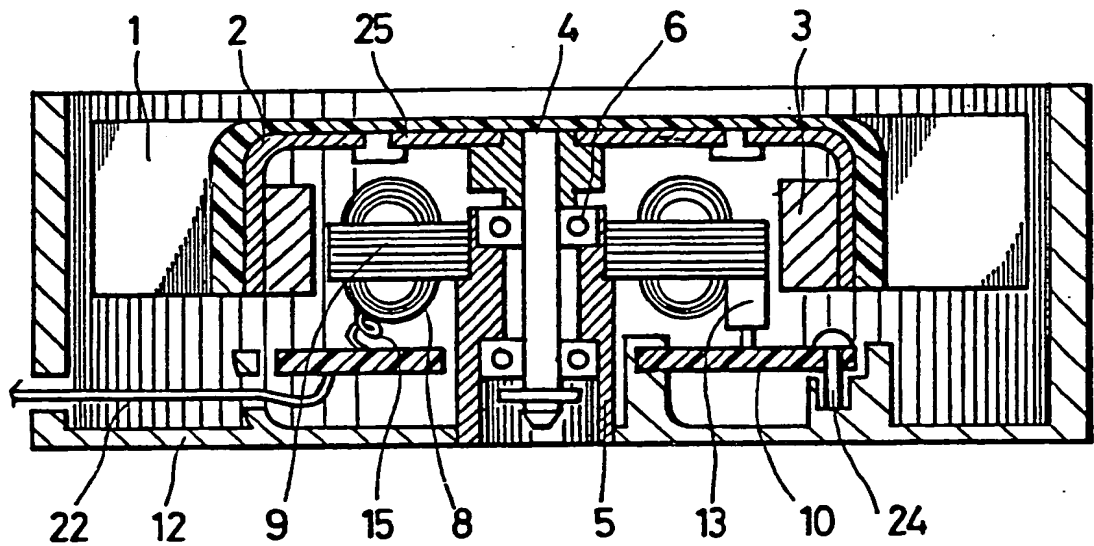


FIG. 2

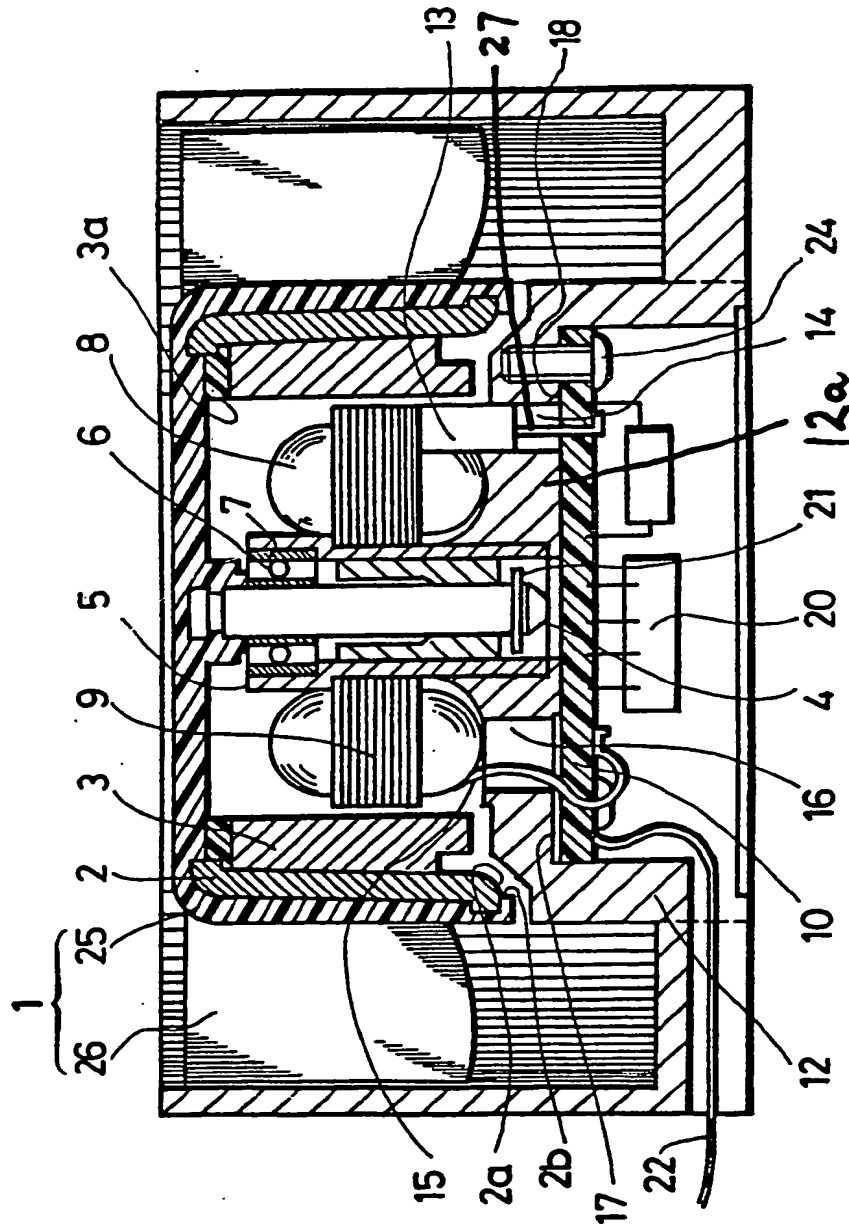


FIG. 3

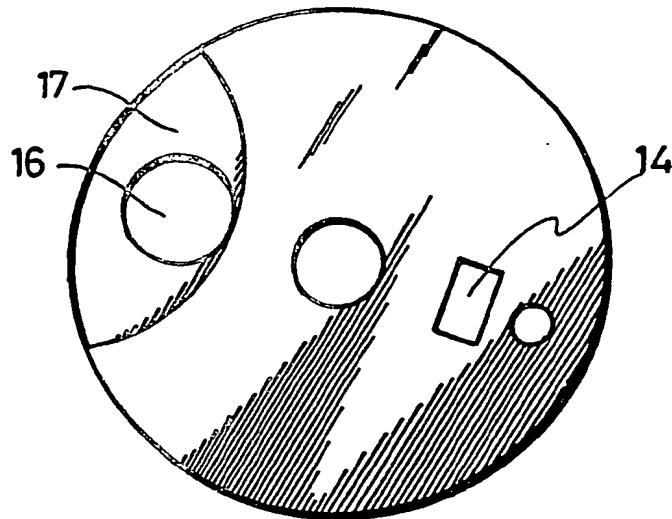


FIG. 4

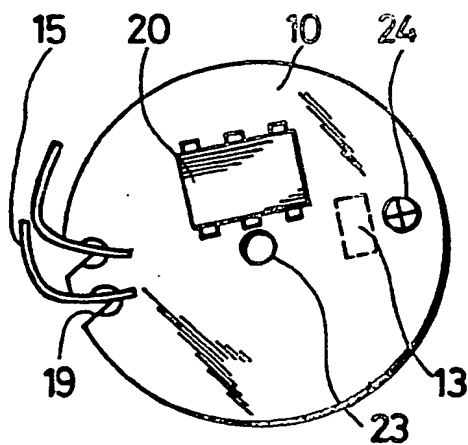
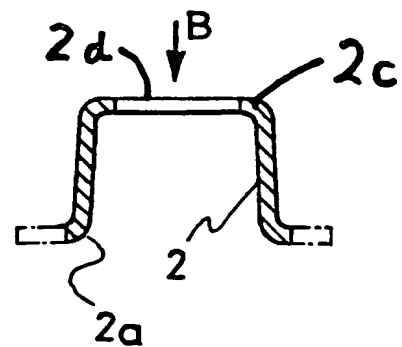


FIG. 5



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EUROPEAN PATENT APPLICATION

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71 Applicant: **SEIKO ELECTRONIC COMPONENTS LTD.**
30-1, Nishitaga 5-chome
Sendai-shi Miyagi(JP)

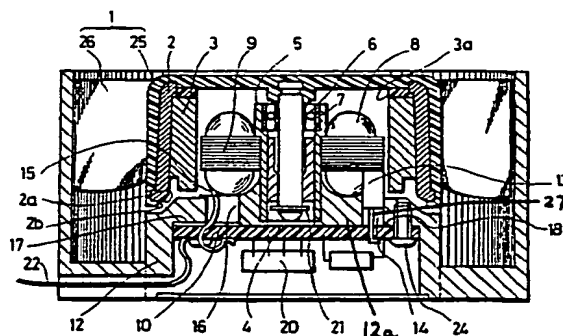
72 Inventor: **Hirama, Hideo**
Seiko Electronic Com. Ltd. 30-1 Nishitaga
5-chome
Sendai-shi Miyagi-ken(JP)
Inventor: **Hayashizaki, Shinichi**
Seiko Electronic Comp. Ltd. 30-1 Nishitaga
5-chome
Sendai-shi Miyagi-ken(JP)

74 Representative: **Miller, Joseph et al**
J. MILLER & CO. Lincoln House 296-302 High
Holborn
London WC1V 7JH(GB)

54 **Axial flow fan.**

67 An axial flow fan comprising a rotary member (1-4, 25) provided with a fan member (1); a motor portion (8,9) of an electric motor for rotating the rotary member (1-4, 25); a circuit board (10) carrying an electrical component or components (20) for controlling the operation of the motor portion (8,9); and a housing (12) having a housing portion (12a) to one side of which the rotary member (1-4, 25) and the motor portion (8,9) are mounted characterised in that the circuit board (10) is mounted on the opposite side of the housing portion (12a), the axial flow fan having been assembled by introducing the rotary member (1-4,25) and the motor portion (8,9) into the housing (12) from the said one side, and introducing the circuit board (10) into the housing (12) from the said opposite side.

FIG. 2



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CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

- ☐ All claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for all claims.
- ☐ Only part of the claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid.
- namely claims:
- ☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

X LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirement of unity of invention and relates to several inventions or groups of inventions.

namely:

1. Claims 1,2,3,4,9: Axial flow fan comprising an electric motor and a circuit board, rotor and circuit board mounted from different sides.
2. Claims 5,6,7,8,10: Axial flow fan rotor construction.

- ☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.
- ☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid.
- namely claims:
- ☒ None of the further search fees has been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims.

namely claims: 1.2.3.4.9